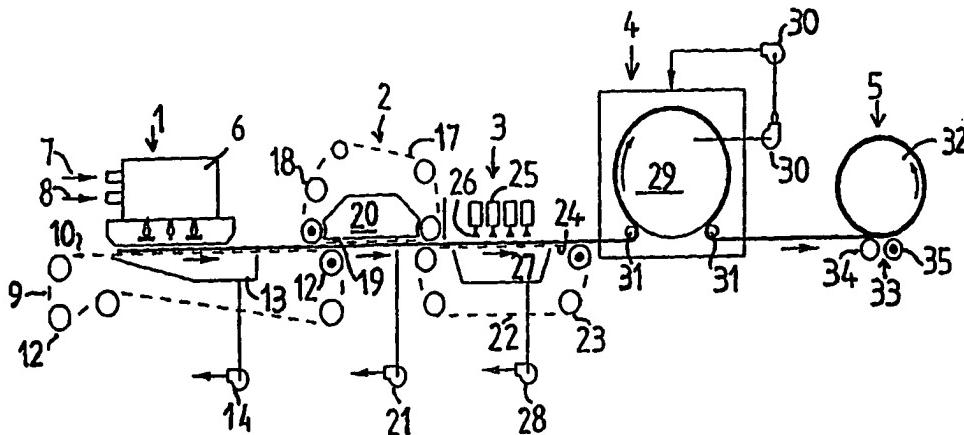




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(54) Title: **A PLANT FOR PRODUCING A FIBRE WEB OF PLASTIC AND CELLULOSE FIBRES**

## (57) Abstract

A plant serves as a mean for production of a fibre web of synthetic fibres, such as plastic fibres and absorbent fibres, such as viscose and cellulose fibres. The plant includes a forming head (1) preliminary to lay a homogeneously and smoothly distributed fibre layer (16) on a net shaped wire (9). Furthermore the plant includes a hydro-entangling section (3) with liquid nozzles (25) with powerful liquid jets to treat the in the forming head (1) formed fibre layer, which consists of both synthetic – and absorbent fibres. The plant also includes an oven (4) subsequently to thermal bond the synthetic fibres with cross bonds in the affected areas. Finally the dried web is wended up in a roller (32). By the help of the plant according to the invention, by higher production speed than known previously a fibre web can be produced, which is far cheaper, and which has a better and more homogeneous structure than similar conventional fibre webs.

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A plant for producing a fibre web of plastic and cellulose fibres

The invention concerns in any case synthetic fibres, such as  
5 plastic fibres and absorbent fibres, such as viscose and cellulose fibres to produce a fibre web, which at least include one heat-treatment section for heating up the synthetic fibres at least to one in advance determined temperature, and at least one hydro-entangling section with liquid nozzles to aim a number  
10 of powerful liquid jets against one made of synthetic fibres and absorbent fibres combined fibre layer.

A such plant is known, where long, carded, synthetic fibres of for instance polypropylene or polyethylene are laid in a web  
15 shaped layer on the top side of a net shaped, endless wire's upper tissue, which while running simultaneously runs in a direction, which points towards the plant's outlet. On the same or on a following wire the fibre layer hereafter is guided through an oven, where the fibres are heated up to such a high  
20 temperature that they will be tied together with cross bonds in the affected areas.

A thermal bonding fibre layer has now been formed, which serve as a framework and supporting web for absorbent fibres, such as  
25 viscose and/or cellulose fibres, which as web can be un-winded from a roller or applied in an air-flow by the help of a known forming head.

A close-meshed wire transports hereafter the supporting web  
30 with the applied fibres through a battery of water nozzles, which send a powerful water jets down against the fibres, which hereby are driven effectively into the underlying, frame-like supporting web.

35 When the water jets touch the close-meshed wire, part of the water is hit back against the supporting web, by the help of which the applied fibres are wind around the cross bonded,

synthetic fibres and are laid closely against the web's lower side, which hereby will be conveyed a smooth and flush surface.

5 The mentioned water exposure is in technical terms called hydro-entangling or spun-lacing. In the following the term hydro-entangling will be used.

The hydro-entangled web is dried in an oven, and finally the web is wind up in shape of a roller.

10 Fibre webs, which are manufactured in this way, are for instance used for products as wet wipes, towels, drapes, and gowns.

15 The above described process can be varied in several ways, which however has this in common that they all start with a carded fibre layer. Typically the layers will be of polypropylene, polyethylene, or viscose, or a mixture of such fibres.

20 The carded made supporting web is soft and suitable for absorbing and intimately connect with the applicated fibres. In the longitudinal direction besides the web has such a matching strength that the process can proceed without a large risk of web breakage, which could lead to expensive stops of production and losses of materials.

25 Another advantage consist of - that during the hydro-entangling process hydrogen bonds are made between the fibres, by which it is avoided that the finished product flock and mote by use or processing.

30 The carding process however is slower than the following processes, which therefore cannot proceed with optimum capacity, this means the yield is reduced to a level, which is set by the carding process. Since plants of this kind are extremely 35 expensive, it must be considered a serious lack that a great part of the known plant thus is not being used to the full extent.

Besides the carding process requires close supervision and control, and it is difficult and complicated to work with, because for instance during running it is necessary to stretch the carded fibre layer.

5

The synthetic fibres, which make up the supporting web is furthermore considerably more expensive than cellulose fibres, and since the known process requires that approximately equal size quantities are being used of the two fibre types, the 10 resulting product becomes expensive.

Even with the above mentioned content of synthetic fibres, the finished fibre web anyhow will suffer from the main lack that there exists an even big difference in the strength respectively 15 in the longitudinal and transverse direction. The strength scale is typically 5:1. Products, which are manufactured of such fibre webs, therefore may tend to part alongside during use. Thus it is easy to stick a finger through the product.

20 A further disadvantage consists of - that the known plant due to the carding process is rather unfit for production of sandwich webs, where the carded fibres become a part of several layers. The known plant can therefore not be used for production of one of today's strongly demanded products, which consists of two 25 non-woven fibre layers with an intermediate air-laid fibre layer, which is tied together with the two others by the help of hydro-entangling.

30 The purpose of the invention is to assign a plant of at the opening mentioned character, which has a simple and cheap structure, which is easy to work with and financially favourable while running, and which furthermore can manufacture at a larger transition speed than known so far.

35 Another purpose of the invention consists of assigning a plant of at the opening mentioned character, by means of which a fibre web with a balanced proportion between the strengths

respectively in the longitudinal and transverse direction can be manufactured.

5 A third purpose of the invention consists of assigning a plant of at the opening mentioned character, which is designed to manufacture fibre webs taking price and features into consideration for optimum proportions between the quantities of fibre types used for manufacturing the web.

10 A fourth purpose of the invention consists of assigning a plant of at the opening mentioned character, by means of which a fibre web can be manufactured, which has a more homogeneous and precise distribution of fibres than formerly known.

15 A fifth purpose of the invention consists of assigning a plant of at the opening mentioned character, by means of which a fibre web with tighter tolerances than formerly known can be manufactured.

20 A sixth purpose of the invention consists of assigning a plant of at the opening mentioned character, by means of which a sandwich fibre web easily can be manufactured.

25 The new and specific, by means of which this is achieved according to the invention consist of the plant besides include an air-laying section including means during operation to generate a mainly vertical descending air-flow through at any rate the upper tissue on a mainly vertical running net shaped, endless wire, and successively supply the air-flow with at least 30 synthetic fibres and distribute these in a smooth and homogenous, web shaped layer on the upper side of the wire's upper tissue, which under here runs in one against the plant's outlet pointing direction.

35 When the known plant's carding process thus is replaced by a reliable and financially favourable air-laying process the plant's remaining equipment is now made able to operate at optimum production speed, simultaneously the process becomes

easy to control. The fibres can be distributed homogeneously and precisely with an equal orientation in all directions, thus the finished fibre web achieves approximately same strength in longitudinal and transverse direction, and besides manufacturing 5 with tight tolerances becomes possible.

Now the process does not require a large strength in the longitudinal direction anymore, and the expensive synthetic fibres can among other things for this reason to a large extent 10 be replaced by cheaper cellulose fibres, by means of which the finished fibre web's absorbent features are improved favourably, and the cost price is being reduced.

It is especially favourable, when the absorbent fibres are added 15 at the same time as the synthetic fibres in the same air-laying section, since the fibres hereby are mixed intimately from start, and the supporting web will be integrated in the forming process.

20 For the purpose a forming head can be used, which include a under the wire's upper tissue placed suction box, which is connected to a vacuum air pump, one above the wire placed house with one or more fibre inlets, and one in the house above the wire placed number of rotary wings for while operating to 25 distribute the fibres in a flush layer on the upper side of the wire's upper tissue.

A simple and cheap construction form for the plant can be constructed of a forming head for at a time to form both the 30 synthetic fibres and the absorbent fibres, a hydro-entangling section, and an oven with sufficient high treatment-temperature to thermal bond the synthetic fibres in the affected areas.

By this construction the thermal bonding of the synthetic fibres 35 takes place in the same oven, which is used for drying the hydro-entangled fibre web. When a specific thermal bonding oven is inserted between the forming head and the hydro-entangling section, the process can be controlled very precisely, because

the temperatures in respectively the thermal bonding oven and the later drying oven can be adjusted to an optimum for the respective processes. Furthermore the fibre web is now stabilised, when it passes through the hydro-entangling process,  
5 which therefore can proceed with an optimum effect and without a large waste of loose fibres.

When the single forming head in one of the two above mentioned construction forms for the plant according to the invention is  
10 replaced with three on one-and-another following forming heads, the plant can be successfully used for production of sandwich fibre webs, since the middle forming head then mainly is supplied with for instance cellulose fibres, while the two other forming heads are supplied with synthetic fibres or both  
15 synthetic fibres and cellulose fibres.

The invention regards also a fibre web, which is manufactured by the help of the above mentioned plant according to the invention, and which contains synthetic fibres as well as  
20 absorbent fibres. Due to the production process this web has a structure with a homogenous orientation of the fibres in all directions and a good balance between the strengths respectively in longitudinal and transverse direction.

25 An effectively tied and therefore strong fibre web is achieved, when the synthetic fibres are bi-component fibres, which each consists of a core of at first plastic and then of another one of plastic with a higher melting point than the first. When this form of synthetic fibres are being used, bonding is secured in  
30 all places, where the fibres meet, without a simultaneous risk of the core to melt, by which the bonding feature would be lost.

35 The by the help of the plant according to the invention manufactured fibre web can favourably have a percentage content of cellulose fibres of between 50 and 95, mainly between 60 and 90, and especially between 75 and 85, at which the web becomes

substantially cheaper than the conventional fibre webs of this type.

The invention is explained in details below, where solely  
5 examples of construction forms are described according to the drawing, where

Fig. 1 shows schematically a first construction form for a plant according to the invention

10

Fig. 2 shows schematically a second construction form for a plant according to the invention.

15

Fig. 3 shows schematically a third construction form for a plant according to the invention, and

Fig. 4 shows schematically a fourth construction form for a plant according to the invention.

20 In fig. 1 a first construction form for a plant according to the invention can be seen. The main components are a forming head 1, a conveyor 2, a hydro-entangling section 3, an oven 4, and a winder section 5.

25 The forming head 1 consists of a house 6 with a fibre inlet 7 for synthetic fibres, for instance plastic fibres, and a fibre inlet 8 for instance cellulose fibres.

Below the house a net shaped wire can be found 9, which with an  
30 upper tissue 10 and a lower tissue 11 runs above roller 12.

Close under the wire's upper tissue 10 a suction box 13 is placed, which is connected to a vacuum pump 14, and above the wire's upper tissue 10 besides a number of,  
35 f rotating wings 15 are placed.

During operation the vacuum pump 14 provides via the suction box 13 and the house 6 an air-flow, which from an unshown source for

synthetic fibres and likewise an un-shown source for absorbent fibres, as for instance cellulose fibres, leads synthetic fibres and absorbent fibres into the house 6 via respectively the fibre inlet 7 and the fibre inlet 8.

5

The air-flow flows down through the wire's upper tissue 10, while the fibres are kept back on the tissue's upper side, where those are mixed and distributed by the rotating wings 15 in an flush and homogeneous fibre layer 16 with a random and even 10 orientation of the fibres in all directions.

Simultaneously the wire runs 9's upper tissue 10 in the arrow shown direction against the plant's outlet at the winder section 5, and delivers under here the fibre web 16 to the conveyor 2.

15

This conveyor 2 consists of a wire 17, which overlaps the forming head's wire 9 and runs over rollers 18. The wire 17 has a lower tissue, which is placed on the upper side of the fibre layer 16.

20

The suction box 20, which is connected to a vacuum air pump 21 and is placed above the wire 17's lower tissue, generates a negative pressure, which holds the fibre layer 16 on to the wire 17's lower tissue 19, which thereby will be able to transport 25 the fibre layer 16 to the hydro-entangling section 3 in the with the arrow shown direction.

This hydro-entangling section 3 consists of a relatively close-meshed wire 22, which overlaps the conveyor's 2's wire 17 and 30 runs above rollers 23. The wire 22 has an upper tissue 24, which is placed on the lower side of the fibre layer 16.

Above the wire 22's upper tissue 24 is placed a number of water nozzles 25, which send powerful water jets 26 down against the 35 fibre layer 16, which under here is hold to the web by an underlying suction box 27, which is connected to a vacuum air pump 28. Water and loose fibres will be removed from the suction box 27 by the pump 28.

The water jets wind the fibre web's different fibres together in a strong bond. A part of the water fights at the meeting with the close-meshed wire 22's upper tissue 24 besides back against the fibre web's lower side, which by means of this is supplied 5 a flush and smooth surface.

Furthermore the hydro-entangling treatment effects that between the fibres, hydrogen bonds will be formed, which prevent flocculation and dust by use and during processing.  
10

After the hydro-entangling treatment, the now relatively strong and well coherent fibre web runs into an oven 4, which works at a sufficient high temperature to thermal bond the synthetic fibres in the affected area. Simultaneously the web will be 15 dried.

In the oven 4 a rotating roll 29 is equipped with a perforated wall, which allows a warm flow of air to pass. The air-flow will be re-circulated as shown by the help of fans 30.  
20

During the passage of the oven 4 the fibre web 16 runs around rollers 31 and the in arrow pointing direction rotating roll 29, by means of which the warm air will be forced through the fibre web, which dries, simultaneously a cross bond in the contact 25 points will be formed mutually between the synthetic fibres and to a certain extent also between the synthetic fibres and the absorbent fibres.

Finally the finished fibre web will be winded up into a roller 30 of fibre web 32 in the roller-section 5, which fundamentally consists of a winder 33 with a driven roller 34 and an idler roller 35.

The in fig. 2 shown other construction form for a plant 35 according to the invention separates itself alone from the above described and in fig. 1 shown first construction form by, now a special thermal bonding oven 36 is inserted between the conveyor

2 and the hydro-entangling section 3. Similar parts are therefore indicated with the same reference numbers.

5 The thermal bonding oven 36 is a continuos oven, which the upper tissue 37 passes through on a wire 38, which runs above roller 39. The fans 40 serve the purpose of re-circulating the air across through the fibre web 16 and the wire 38's upper tissue 37, which carries the fibre web.

10 The thermal bonding oven 40 works with a temperature, which is sufficient high to bond the synthetic fibres together in the affected areas, however not that high that the fibres melt noticeably.

15 The process in the thermal bonding oven is easiest controlled, when bi-component fibres are used. When the core for example has a melting point of 180 Celsius and the shell a melting point of for example 135 Celsius, the temperature in the oven must be kept in a spot between these two temperatures to efficiently 20 cross bond the synthetic fibres in the affected areas without risking the core to melt simultaneously.

25 One of the advantages, which is obtained by using this special thermal bonding oven 36, consists of the fibre web 16 is stabilised in advance, thus the following hydro-entangling process can proceed with increased certainty and less fibre waste, which must be lead away in the wastewater.

30 Another advantage consists of the oven 4, now just needs to work as a drying oven, and therefore can work with a here fore fitted lower temperature, which size furthermore is uncritical.

35 The in fig. 3 shown third construction form for a plant according to the invention separates itself from the above described and in fig. 1 first shown construction form by, now instead of only one forming head three exist placed after one-another 41, 42, and 43. Each of these forming heads are constructed in the same way as the first constructions form's

forming head 1. Similar parts are therefore indicated with the same reference numbers.

When the plant in this way is supplied with three forming heads, 5 it can be used for production of sandwich-fibre web, which typically consist of a soft thermal bonded top- and bottom layer with an absorbent core. The sandwich-fibre web can for example have following combination.

10

**Example 1**Bottom layer 15 GSM

15 The proportions between the synthetic fibres and the absorbent fibres , such as cellulose fibres 10 - 5. This means that 67% of the bottom layer consists of synthetic fibres and 33% of absorbent fibres.

20 Middle layer 30 GSM

The proportions between the synthetic fibres and the absorbent fibres, such as cellulose fibres 3 - 27. This means that 10% of the middle layer consists of synthetic fibres and 90% of 25 absorbent fibres.

Top layer 15 GSM

30 The proportions between the synthetic fibres and the absorbent fibres, such as cellulose fibres 7 - 8. This means that 47% of the top layer consists of synthetic fibres and 53% of absorbent fibres.

35 The process processes in a way that the first forming head 41 will be supplied with the fibres for the bottom layer, the other forming head 42 with the fibres for the middle layer, and the third forming head 43 with the fibres for the top layer, thus the three layers will be formed in each layer's separate forming

head 41, 42, 43 and successively will be laid on top of one-another. Subsequently the process continues in the same way as described for the first construction form.

5 The in fig. 3 shown fourth construction form for a plant according to the invention separates itself from the above mentioned and in fig. 3 shown third construction form by, now similar to the other construction form, and as shown in fig. 2, a special continuous thermal bonding oven 36 is inserted between 10 the conveyor and the hydro-entangling section 3. Similar parts are therefore also in this case indicated with the same reference numbers.

With this setting of the plant according to the fourth 15 construction form the same advantages will be achieved as described in connection with the description of the other construction form.

The in the below table indicated data respectively for a card 20 based product and a product according to the invention serves the purpose of making the advantages clear, which can be achieved by the invention.

Example 2

| Product features  | Card based product | Product according to the invention |
|---|--------------------|------------------------------------|
| Content of thermal bonding fibres                           | 50 %               | 5 % - 45 %                         |
| Content of cellulose fibres                                 | 50 %               | 95 % - 55 %                        |
| Length of thermal bonding fibres                            | 12 - 60 mm         | 2 - 25 mm                          |
| Length of viscose fibres                                    | 6 - 60 mm          |                                    |
| Length of cellulose fibres                                  | 0 - 6 mm           | 0 - 6 mm                           |
| Length of alternative fibres (for example absorbent fibres) |                    | 2 - 25 mm                          |
| Dry strength, longitudinal direction                        | 100 N/50mm *)      | 25-50 N/50mm *)                    |
| Dry strength, transverse direction                          | 20 N/50mm *)       | 15-30 N/50mm *)                    |
| Wet strength, longitudinal direction                        | 100 N/50mm *)      | 19 N/50mm *)                       |
| Wet strength, transverse direction                          | 20 N/50mm *)       | 11 N/50mm *)                       |
| * ) gram weight   | 65 g / sqm         | 65 g / sqm                         |

5 As it can be seen, a great part of the expensive synthetic fibres in the conventional card based product has been replaced by cheaper cellulose fibres in the inventive product, which in this way can manufacture at a far lower price than the conventional product.

10

Simultaneously the inventive product's strength is favourable fairly identical in the longitudinal and transverse direction,

while the conventional product's corresponding strength ratio is as 5 - 1.

It must be noted that the above described and on the drawing shown constructions forms only serve as considerate examples of, 5 how a plant according to the invention can be arranged.

In this way the plant can, within the frame of the invention's protection scale after need be supplied with two, four, or a 10 bigger number of forming heads, which besides do not necessarily need to be placed in a row just after one-another.

Furthermore in the production line one or several further sections can be inserted to in dependency of the wished quality 15 to treat the fibre web.

Claims

1. Plants for at least synthetic fibres, such as plastic fibres and absorbent fibres, such as viscose and cellulose fibres to produce a fibre web, and which include at least one heat-treatment section to heat up at least the synthetic fibres to one in advance determined temperature, and at least one hydro-entangling section with liquid nozzles to point a number of powerful liquid jets against one combined fibre layer of synthetic fibres and absorbent fibres, **characterized** in that the plant besides includes an air-laying section with means during process to generate one mainly vertical downward air-flow through at least the upper tissue on one in advance vertical running net-shaped, endless wire, and successively supply the airflow with at least synthetic fibres and distribute these in a web shaped layer on the upper side of the wire's upper tissue, which under here runs in one against the plant's outlet pointing direction.
2. Plant according to claim 1, **characterized** in that it includes means to supply the generating air-flow with synthetic as well as absorbent fibres.
3. Plant according to claim 1 or 2, **characterized** in that mentioned in procedural order - includes an air-laying section for forming a web shaped layer of synthetic fibres and absorbent fibres, one hydro-entangling section, and one heat-treatment section with a sufficient high treatment-temperature to thermal bond the synthetic fibres in the affected areas.
4. Plant according to claim 1 or 2, **characterized** in that - mentioned in procedural order - includes an air-laying section to form a web shaped layer of synthetic fibres and absorbent fibres, one first heat-treatment section with sufficient high treatment-temperature to thermal bond the synthetic fibres in the affected areas, one hydro-entangled section, and one other

heat-treatment section with a sufficient high treatment-temperature for at least drying the hydro-entangled web.

5. Plant according to claim 1 or 2, characterized in that - mentioned in procedural order - includes one first air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, one other air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, a third air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, one hydro-entangling section, and one heat-treatment section with sufficient high treatment- temperature to thermal bond the synthetic fibres in the affected areas and for drying the hydro-entangled web.
- 15 6. Plant according to claim 1 or 2, characterized in that - mentioned in procedural order - includes a first air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, one other air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, a third air-laying section for forming a web shaped layer of synthetic fibres and/or absorbent fibres, one first heat-treatment section with sufficient high treatment- temperature to thermal bond the synthetic fibres in the affected areas, one hydro-entangling section, and one other heat-treatment section with sufficient high treatment- temperature for at least drying the hydro-entangled web.
- 20 25 30 35 7. Plant according to each of the claims 1 - 6, characterized in that each air-laying section includes one under the wire's upper tissue placed suction box, which is connected to a vacuum pump, one above the wire placed house with one or more fibre inlets, and one in the house above the wire placed number of rotating wings for during running to distribute the fibres in a smooth layer on the upper side of the wire's upper tissue.

8. Fibre web, which consists of air-laid fibres, which are treated with warm and powerful water jets, characterized in that the fibres include as well synthetic fibres as absorbent fibres.

5:

9. Fibre web according to claim 8, characterized in that at least a part of the synthetic fibres are bi-component fibres, which each consists of a core of one first plastic and a shell of one other plastic with a higher melting point than the first.

10

10. Fibre web according to claim 8 or 9, characterized in that it has a percentage content of cellulose fibres on between 50 and 95, mainly between 60 and 90, and especially between 75 and 85.

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25

**AMENDED CLAIMS**

[received by the International Bureau on 11 March 1999 (11.03.99);  
original claims 1-10 replaced by new claims 1-8 (2 pages)]

- 5        1. A plant for producing a nonwoven fabric at least of synthetic fibres, such as plastic fibres and absorbent fibres, such as viscose and cellulose fibres, and which comprises:
- 10      - at least one air-laying station consisting of an endless wire, one under said wire placed suction box connected to a vacuum pump, one above the upper wire part placed house with one or more fibre inlets, and a number of above the wire in the house rotatably arranged wings for during operation distributing the fibres in a nonwoven web upon the upper wire part,
- 15      - at least one heat-treatment station arranged downstream the at least one air-laying station for bonding the synthetic fibres by heating the web,
- 20      - at least one hydro-entangling station arranged downstream the at least one heat-treatment station for directing a number of powerful liquid jets against the bonded web, and
- 25      - means for continuous transport of the web through the plant.
- 30      2. A plant according to claim 1 wherein at least one drying station for drying the hydro-entangled nonwoven web is arranged downstream the hydro-entangling station.
- 35      3. A plant according to claim 2 wherein the drying station is adapted to act upon the hydro-entangled nonwoven web with a temperature sufficient to further bonding the synthetic fibres.
- 40      4. A plant according to claim 2 or 3 wherein the drying station comprises a rotatable drum which has a perforated wall for during operation supporting a length of the hydro-entangled nonwoven web and simultaneously allowing a stream of air to pass.
- 45      5. A plant according to each of the claim 1 - 4 wherein the plant comprises at least three in succession arranged air-laying stations.
- 50      6. A nonwoven fabric consisting of at least synthetic fibres, such as plastic fibres and absorbent fibres, such as viscose and cellulose fibres, and produced in a plant comprising:
- 55      - at least one air-laying station consisting of an endless wire, one under said wire placed suction box connected to a vacuum pump, one above the upper wire part placed house with one or more fibre inlets, and a number of above the wire in the house rotatably arranged wings for during operation

distributing the fibres in a nonwoven web upon the upper wire part,

- 5 - at least one heat-treatment station arranged downstream the  
at least one air-laying station for bonding the synthetic  
fibres by heating the web,  
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- 10 - at least one hydro-entangling station arranged downstream the  
at least one heat-treatment station for directing a number of  
powerful liquid jets against the bonded web, and

- means for continuous transport of the web through the plant.

- 15 7. A nonwoven fabric according to claim 6 wherein at least  
part of the synthetic fibres are bi-component fibres, which  
each consists of a core of a first plastic surrounded by a  
second plastic having a higher melting point than the first  
one.

- 20 8. A nonwoven fabric according to claim 6 or 7 wherein the  
cellulose fibres are present in an amount of between 50 % and  
95 %, mainly between 60 % and 90 %, and especially between 75 %  
25 and 85 %.

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## INTERNATIONAL SEARCH REPORT

1

International application No.

PCT/DK 98/00443

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC6: D04H 1/54 // D04H 1/46, D04H 1/70**  
 According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC6: D04H**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE, DK, FI, NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**WPI, PAJ**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | US 5375306 A (ROUSSIN-MOYNIER), 27 December 1994<br>(27.12.94), column 1, line 5 - line 9; column 2,<br>line 17 - line 59; column 3, line 34 - line 62,<br>column 4, lines 1-21 | 1-3,7,8               |
| Y         | column 3, line 3 - line 10  | 9                     |
| A         | see the whole document  | 4-6,10                |
|           | --  |                       |
| X         | US 5240764 A (HAID ET AL), 31 August 1993<br>(31.08.93), column 2, line 5 - line 39   | 4,10                  |
| Y         | column 2, line 9 - line 39  | 5,6                   |
| A         | see the whole document  | 1-3,7-9               |
|           | --  |                       |

 Further documents are listed in the continuation of Box C. See patent family annex.

- \* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report  
**12-01-1999****8 January 1999**Name and mailing address of the ISA/  
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 98/00443

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                | Relevant to claim No. |
|-----------|---|-----------------------|
| Y         | EP 0171806 A2 (CHICOPEE), 19 February 1986<br>(19.02.86), page 5, line 26 - line 36; page 6,<br>line 13 - line 23 | 9                     |
| A         | page 3, line 29 - page 5, line 36<br>--   | 1-8,10                |
| Y         | US 4931355 A (RADWANSKI ET AL), 5 June 1990<br>(05.06.90), column 5, line 66 - column 8, line 39                  | 5,6                   |
| A         | column 3, line 31 - column 8, line 29, figure 1<br>--   | 1-4,7-10              |
| A         | US 4555430 A (MAYS), 26 November 1985 (26.11.85),<br>column 2, line 1 - column 6, line 43<br>--<br>-----          | 1-10                  |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/12/98

|                               |  |
|-------------------------------|--|
| International application No. |  |
| PCT/DK 98/00443               |  |

| Patent document cited in search report |            | Publication date | Patent family member(s) |              | Publication date |
|--|------------|------------------|-------------------------|--------------|------------------|
| US                                     | 5375306 A  | 27/12/94         | DE                      | 69121694 D,T | 23/01/97         |
|  |            |                  | EP                      | 0504368 A,B  | 23/09/92         |
|  |            |                  | FR                      | 2671772 A    | 24/07/92         |
|  |            |                  | AT                      | 141964 T     | 15/09/96         |
|  |            |                  | CA                      | 2070773 A    | 09/04/92         |
|  |            |                  | FR                      | 2667622 A,B  | 10/04/92         |
|  |            |                  | WO                      | 9206237 A    | 16/04/92         |
| <hr/>                                  |            |                  | <hr/>                   |              |                  |
| US                                     | 5240764 A  | 31/08/93         | NONE                    |              |                  |
| <hr/>                                  |            |                  | <hr/>                   |              |                  |
| EP                                     | 0171806 A2 | 19/02/86         | AU                      | 4624485 A    | 20/02/86         |
|  |            |                  | BR                      | 8503890 A    | 27/05/86         |
| <hr/>                                  |            |                  | <hr/>                   |              |                  |
| US                                     | 4931355 A  | 05/06/90         | AU                      | 3147489 A    | 21/09/89         |
|  |            |                  | CA                      | 1315082 A    | 30/03/93         |
|  |            |                  | DE                      | 8916164 U    | 09/06/94         |
|  |            |                  | DE                      | 68913057 D,T | 09/06/94         |
|  |            |                  | EP                      | 0333228 A,B  | 20/09/89         |
|  |            |                  | SE                      | 0333228 T3   |                  |
|  |            |                  | ES                      | 2049268 T    | 16/04/94         |
|  |            |                  | JP                      | 2026972 A    | 29/01/90         |
|  |            |                  | KR                      | 9705852 B    | 21/04/97         |
|  |            |                  | MX                      | 167630 B     | 31/03/93         |
| <hr/>                                  |            |                  | <hr/>                   |              |                  |
| US                                     | 4555430 A  | 26/11/85         | NONE                    |              |                  |
| <hr/>                                  |            |                  | <hr/>                   |              |                  |